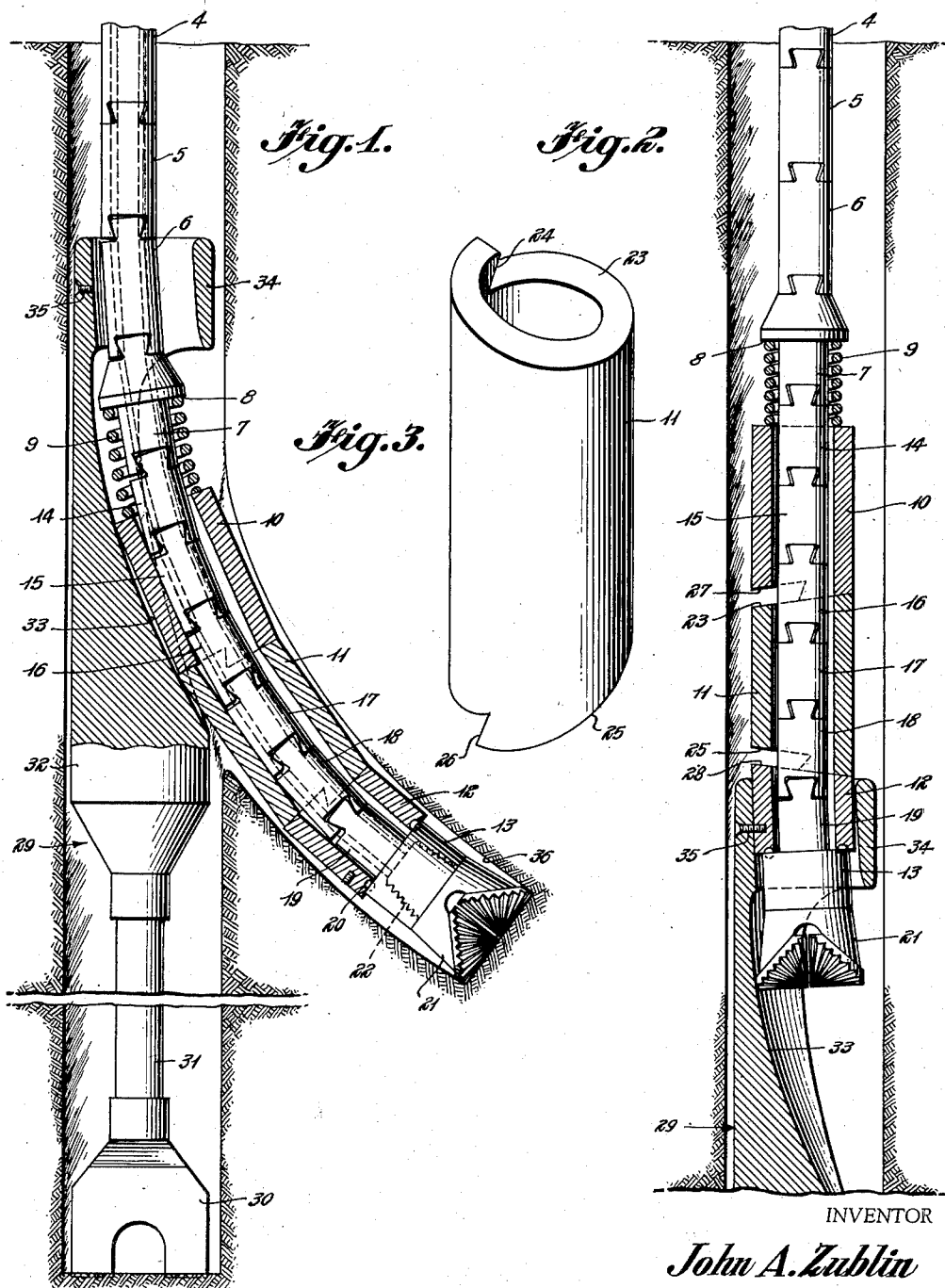


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 APPARATUS FOR DRILLING DEVIATING BORES
 UTILIZING A PLURALITY OF STRAIGHT
 TUBULAR DRILL GUIDE SECTIONS
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APPARATUS FOR DRILLING DEVIATING
BORES UTILIZING A PLURALITY OF
STRAIGHT TUBULAR DRILL GUIDE
SECTIONS

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The present invention relates to apparatus for drilling lateral bores which deviate from existing vertical well bores.

Pursuant to the present invention there are utilized a plurality of short, rigid, straight, tubular drill guide sections which surround a flexible, non-resilient drill string section. The drill guide sections are individually rotatable on the flexible drill string section. The drill guide sections have complementary engaging angular end surfaces. When adjacent drill guide sections are in one position of relative rotation their engaging angular end surfaces cause the sections to assume a substantially straight, aligned configuration. When, however, the adjacent sections are rotated to another relative position, their engaging angular end surfaces cause the sections to form an angle relative to each other.

A drill bit is secured to the lower end of the flexible drill string section and the tubular drill guide sections are positioned above the bit. This assembly can be lowered into an existing well bore while the tubular drill guide sections are in positions of relative rotation to cause them to assume a substantially straight, aligned configuration. The overall lateral dimensions of the apparatus are thus limited and no difficulty is encountered in lowering the assembly into the existing well bore.

A whipstock is positioned within the existing well bore at the location at which it is desired that the lateral bore deviate from the existing bore. This whipstock may be lowered into the well individually in advance of the drilling assembly or it may be lowered simultaneously therewith. The whipstock is provided with a curved guideway through which the short, straight drill guide sections pass during drilling of the first portion of the lateral bore. This curved guideway serves to initially force the drill bit laterally into the wall of the existing well bore to begin the drilling of the lateral bore. As the drilling proceeds, the curved guideway of the whipstock causes adjacent drill guide sections to rotate relative to each other and to assume positions of relative rotation causing adjacent drill guide sections to form an obtuse angle relative to each other. The deviation of the bit from the existing well bore is controlled as the drilling proceeds by the angles formed by adjacent tubular drill guide sections. The laterally deviating bore prevents relative rotation of drill guide sections which are positioned within that bore so that there is no possibility of the drill guide sec-

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tions returning to a straight, aligned configuration during actual drilling of the lateral bore.

I prefer to provide resilient means which urge the tubular drill guide sections toward each other and which have a tendency to retain the drill guide sections in positions of relative rotation which result in the sections forming angles relative to each other. In other words, the resilient means tends to oppose relative movement of the drill guide sections while those sections form angles relative to each other.

The purpose of the present invention is to obtain a rigid, laterally deflected drill guide for that part of a flexible drill string section which has passed through a whipstock within an existing well bore. Another object of the invention is to provide a drilling assembly which can be easily and rapidly lowered into an existing well bore and which provides a rigid guide for the drill bit during drilling of a lateral bore. Still another object of the invention is to limit the overall lateral dimensions of an assembly for drilling lateral bores during the lowering of that assembly into an existing well bore. Another object of the invention is to provide a flexible drill string section and a rigid guide therefor, in combination with a whipstock which is capable of controlling or altering the configuration of the rigid drill guide at the point of deviation of the lateral bore in the well.

Further objects and advantages of the invention will be understood by reference to the following description taken in connection with the accompanying drawing, wherein:

Figure 1 is a view partly in longitudinal section and partly in side elevation of an assembly embodying the present invention and which is positioned in a well;

Figure 2 is a view similar to Figure 1 illustrating the apparatus in condition for lowering into an existing well bore and prior to initiation of drilling of a lateral bore; and

Figure 3 is a perspective view of one of the tubular drill guide sections.

A conventional tubular drill string is designated by the reference numeral 4. Secured to the lower end of the drill string 4 is a section of heavy duty flexible drill pipe of the type described and claimed in my Patent No. 2,515,366. The elements 5 and 6 of the flexible drill string section may be exactly as illustrated in the aforementioned patent. The element 7 is provided with a downwardly facing shoulder 8 which acts as a stop for a resilient means such as a compression spring member 9. The lower end of the

compression spring member 9 engages the upper end surface of the uppermost tubular drill guide section 10. A second tubular drill guide section 11 is positioned below the section 10. A further tubular drill guide section 12 is positioned between the section 11 and the terminal member 13 of the flexible drill string section. The flexible drill string section within the tubular drill guide sections is made up of the elements 14, 15, 16, 17, 18 and 19 which are similar to the elements 5 and 6. The terminal member 13 of the drill string section is secured to the element 19. Anti-friction bearing means 20 are provided between the terminal member 13 and the lowermost drill guide section 12. A drill bit 21 is threadedly secured at 22 to the terminal member 13.

The angular end surfaces of the tubular drill guide members can be best understood by reference to Figure 3. The drill guide section 11 is shown as having an upper spirally cammed end surface 23 which forms a single tooth 24. The lower end surface of the drill guide section 11 is comparably cammed in a spiral as indicated at 25 and is provided with a single tooth 26. The lower end surface 27 of the drill guide section 10 is spirally cammed and the upper end surfaces 28 of the drill guide section 12 is cammed in a similar manner.

I provide a whipstock which is designated generally by the reference numeral 29. This whipstock has a foot 30, a supporting standard 31 and a main body portion 32. The main body portion 32 is provided with a curved guideway 33 at the upper end of which is a collar 34.

The apparatus can be arranged as illustrated in Figure 2 during lowering into an existing well bore. The drill bit 21 is positioned at the upper end of the curved guideway 33 of the whipstock. The whipstock may be secured to the tubular drill guide section 12 by means of a shearable screw 35. The tubular drill guide sections 10, 11 and 12 have been rotated relative to each other so that they are in substantially straight alignment. This relative rotation of the tubular drill guide sections results in some compression of the spring member 9. The lateral dimensions of the assembly are thus limited, and no difficulty is encountered in lowering the apparatus into an existing vertical well bore.

When the assembly has reached the position in the well at which it is desired to drill a lateral bore, the whipstock 29 will be supported by the foot 30 and the standard 31. The weight of the drill string above the apparatus illustrated in the drawing will shear the screw 35 and, upon lowering of the drill string, the drill bit 21 will be deflected laterally by the curved guideway 33. Rotation of the drill string will initiate the drilling of a lateral bore 36. The drill guide sections 12, 11 and 10 will be caused to assume the relative positions illustrated in Figure 1 of the drawing as those sections pass through the whipstock. In those positions of the drill guide sections the teeth on their respective engaging end surfaces are in contact and the spring member 9 has been permitted to expand from the compressed condition of Figure 2. The spring member 9 thus tends to assist the tubular drill guide sections to maintain their respective positions illustrated in Figure 1. The engaging teeth on the mating end surfaces of the drill guide sections also assist in preventing the drill guide sections from departing from the relative positions illustrated in Figure 1. As the assembly enters the deviating bore

36 the walls of that bore will also aid in maintaining the drill guide sections in the relative positions indicated in Figure 1 of the drawing.

The apparatus can be withdrawn from the well by merely elevating the drill string 4. The flexible drill string section and its surrounding drill guide sections will first be withdrawn from the lateral bore 36. As the drill guide sections 10, 11 and 12 pass upwardly through the whipstock 29 there will be a tendency for the drill guide sections to return to their original positions as illustrated in Figure 1, but it is not essential that the elements return to a true, straight line configuration. The drill bit 21 will engage the collar 34 and the whipstock will be withdrawn from the well with the other elements of the apparatus.

I have illustrated and described apparatus which includes only the three tubular drill guide sections 10, 11 and 12. It is possible to increase the number of such drill guide sections and this may be found advisable in some instances. It will be apparent that the portion of the flexible drill string section which is above the drill guide sections, and which is illustrated as consisting of the tubular elements 5, 6 and 7, may be made of greater length by simply increasing the number of such elements. The length of the lateral bore 36 may be made as long as is desirable by thus providing sufficient length of the flexible drill string.

I have described the use of the present apparatus for initiating the drilling of a lateral bore as well as for the purpose of actually drilling such a bore.

I have illustrated and described what I now consider to be a preferred embodiment of the present invention. It is to be understood, however, that the illustrated and described embodiment is exemplary only, and that various alterations and modifications may be resorted to without departing from the broader scope of the invention as defined by the following claims.

Having thus described my invention, I claim:

1. Apparatus for drilling a lateral bore deviating from an existing well bore comprising a flexible, non-resilient drill string section, a drill bit secured to the lower end of and rotatable with said drill string section, a plurality of rigid, tubular drill guide sections in end to end engaging relationship surrounding said drill string section above said drill bit said drill guide sections being rotatably mounted on said drill string section and being independently rotatable relative to each other and relative to said drill string section, the length of said tubular guide sections being greater through one half of the circumference thereof than through the other half, adjacent ends of said tubular guide sections having complementary engaging angular circumferentially extending camming surfaces, said camming surfaces when moved to one limit of their camming action positioning said sections in a substantially straight line, and when moved to the opposite limit of their camming action positioning said sections at an obtuse angle relative to each other, a whipstock having a deflecting guideway through which the assembly passes to first deflect the drill bit laterally to initiate drilling of a lateral bore and to thereafter cause adjacent drill guide sections to form an obtuse angle, and means for resisting relative rotation of adjacent tubular drill guide sections while such sections are forming an obtuse angle.

2. Apparatus for drilling a lateral bore deviating from an existing well bore comprising a flex-

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ible, non-resilient drill string section, a drill bit secured to the lower end of and rotatable with said drill string section, a plurality of rigid, tubular drill guide sections in end to end engaging relationship surrounding said drill string section above said drill bit independently rotatable relative thereto, adjacent tubular drill guide sections having complementary engaging spirally cammed end surfaces causing such adjacent sections to assume a substantially straight, aligned configuration while said sections are in one position of relative rotation to thereby limit the overall lateral dimensions of the apparatus during lowering thereof into an existing well bore and causing such adjacent sections to form an obtuse angle relative to each other while said sections are in another position of relative rotation, said cammed end surfaces having complementary teeth which engage when said drill guide sections are in positions of relative rotation causing adjacent sections to form an obtuse angle.

3. Apparatus as defined by claim 2 in which resilient means urges adjacent spirally cammed end surfaces together.

4. Apparatus for drilling a lateral bore deflecting from an existing well bore comprising, a flexible, non-resilient drill string section, a drill bit

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secured to the lower end of and rotatable with said drill string section, a plurality of rigid tubular drill guide sections in end-to-end engaging relationship surrounding said drill string section above said drill bit, said drill guide sections being rotatably mounted on said drill string section and being independently rotatable relative to each other and relative to said drill string section, the length of said tubular guide sections being greater through one half of the circumference thereof than through the other half, adjacent ends of said tubular guide sections having complementary engaging angular circumferentially extending camming surfaces, said camming surfaces when moved to one limit of their camming action positioning said sections in a substantially straight line, and when moved to the opposite limit of their camming action positioning said sections at an obtuse angle relative to each other.

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